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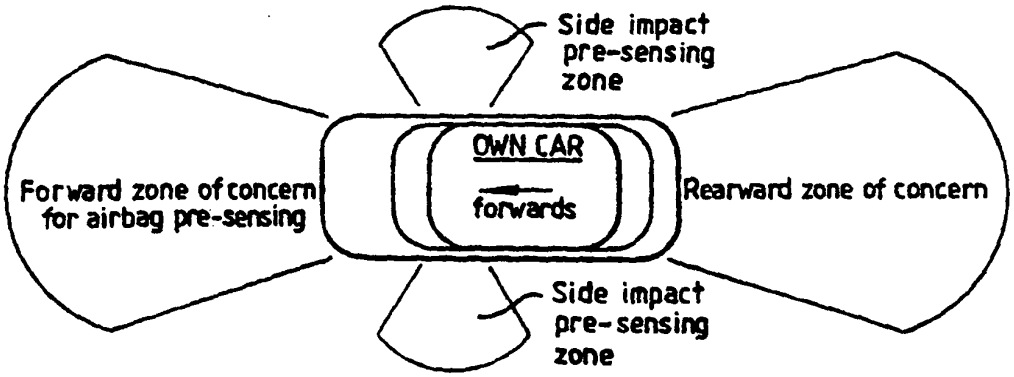
(54) Title: VEHICLE AIRBAG INFLATION CONTROL METHOD



(57) Abstract

An airbag deployment system (1) comprising an airbag inflator (3) operable to inflate the airbag at a variable rate dependant upon a signal from an airbag actuator (5), a sensing system (7) arranged to detect the presence of an object in a predetermined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit (9) which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator (5) to indicate the rate of inflation required for the optimum protection to be provided by the airbag. Typically the sensing system (7) is a radar sensing system.

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VEHICLE AIRBAG INFLATION CONTROL METHOD

Field of the Invention

The invention relates to an improved vehicle airbag deployment and inflation system.

Airbags are recognised as a major breakthrough in the protection of vehicle occupants in the event of collision. Driver and passenger airbags are commonly used to protect the occupants of the front seat of a vehicle and further airbag applications are being proposed and introduced including side airbags and airbags for rear passengers.

Traditionally an airbag is actuated to operate on an impact being sensed. Mounted within a vehicle are impact sensors which sense when a collision has occurred to trigger deployment of the airbag. Sensors are now being developed which detect the position of an occupant and identify the nature of the seat's occupant to allow the airbag actuator to be disabled in certain circumstances. These systems all depend upon the impact sensor within a vehicle operating after a collision has occurred to actuate the airbag.

Many airbags have been developed which have a variable rate of inflation depending upon the severity of impact, or the size and position of the occupant. In many cases the impact sensor detects the velocity of impact after a collision has occurred.

A number of radar systems have been proposed for installation in motor vehicles for detecting objects around a vehicle. Transmitters and receivers are mounted upon the vehicle to detect the presence or approach of objects in a particular direction to be used to help to warn an occupant of a potential collision. Typically, such systems have been developed for collision warning and parking aids.

Summary of the Invention

According to the invention there is provided an airbag deployment system comprising an airbag inflator operable to inflate the airbag at a variable rate dependant upon a signal from an airbag actuator, a sensing system arranged to detect the presence of an object in a pre-determined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator to indicate the rate of inflation required for the optimum protection to be provided by the airbag.

Thus the invention encompasses a system where the method of sensing the presence of an object approaching the vehicle and potentially causing a collision may be radar sensing , or may for example use infrared or ultrasonic sensing.

However it is preferred that the method of sensing is radar sensing so that according to a preferred embodiment of the invention there is provided an improved airbag deployment system comprising an airbag inflator operable to inflate the airbag at a variable rate dependant upon a signal from an airbag actuator, a radar sensing system including at least one radar transmitter and receiver arranged to detect the presence of an object in a pre-determined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator to indicate the rate of inflation required for the optimum protection to be provided by the airbag.

Thus as soon as impact is sensed the airbag inflation can be initiated so that there are no delays in the airbags operation.

The predetermined area in relation to the vehicle in which the presence of an object is to be detected depends on the nature of the airbag to be deployed. The driver and passenger airbags will operate in different collision conditions than a side airbag, for example.

Preferably the system includes at least two radar transmitters and receivers, which are impulse radar transmitters and receivers. In the specification, the term 'impulse radar' is intended to encompass any radar signal of short radio frequency without a carrier wave, and includes radar sometimes referred to as 'broadband radar'. A typical impulse radar sensor is described in published WO90/13048. Such a system can be used to track accurately the path of an object outside the vehicle to accurately predict the potential of a collision, its likely position and time before impact.

Although the radar sensing system may be used in a vehicle, purely for use in the airbag deployment system, the invention is applicable with particular advantage to a vehicle in which the radar sensing system is used also for providing driver information and warnings, such as a parking aid. The advantage is that the same sensors are multifunctional. Preferably the radar sensing system is part of a multifunctional system as described in copending application GB97/01728. Such a system is able to look around the vehicle to detect obstacles about the vehicle and to use the signals detected in a number of collision warning modes.

Preferably the airbag deployment system also includes a pre-arming mechanism as described in our co-pending patent application filed on the same date and entitled

'Improvements relating to Vehicle Airbag Deployment'. In such a system the pre-arm mechanism, coupled to the airbag actuator, comprises a pre-arm control system coupled to the radar sensing system which pre-arms the airbag actuator in readiness for an impact detected by the impact sensor of the airbag deployment system.

In such a system, in theory it would be possible for the airbag actuator to be disabled until a potential collision signal has been received by the pre-arm control system. However, such a system would require an override to be included in the event of a collision occurring due to impact with an object from a position outside the predetermined area scanned by the radar transmitter or receiver.

Preferably however the airbag actuator has two stages in its operation, a pre-arm stage, where the airbag state is changed from non operating to a ready to fill mode, and an actuation stage where the release of the gas to fill the airbag is initiated. The use of the two stages means that the second actuation stage can be made quicker, to reduce the time between impact and the airbag protection being available.

Brief Description of the Drawings

An airbag deployment system in accordance with the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic block diagram of the airbag deployment system;

Figure 2 is a schematic view of the predetermined area scanned by the radar receiver; and,

Figure 3 is a schematic plan view of a vehicle illustrating the position of the sensors and receivers.

Description of the Preferred Embodiment

The airbag deployment system 1 illustrated in the drawings comprises an airbag inflator 3 operable to inflate the airbag (not shown) at a variable rate dependant upon a signal form an airbag actuator 5, a radar sensing system 7 including at least one radar transmitter and receiver arranged to detect the presence of an object in a predetermined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit 9 which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator 5 to indicate the rate of inflation required for the optimum protection to be provided by the airbag.

An impact sensor 11 senses when the impact occurs and then causes the actuator 5 to operate the inflator 3 at the rate already calculated. The impact sensor 11 is standard, the choice of which will be apparent to the skilled addressee of the specification.

Preferably the collision prediction unit 9 also acts as a pre-arm mechanism. On receipt of a signal indicating a likely collision occurrence the collision prediction unit 9 sends a pre-arm signal to the actuator so that it is pre-armed and primed for operation on sensing that collision has occurred.

The airbag actuator is non standard since it has three operating modes, one putting the airbag mechanism into standby, pre-armed mode ready for impact, the second to initiate operation and the third for controlling the inflation rate.

The radar system 7 comprises four sensors 13 shown in figure 3 mounted at the corners of the vehicle in the region of the bumper. Each sensor 13 comprises an impulse radar transmitter and receiver. This arrangement of four sensors allows the envelope around the vehicle to be monitored. The predetermined areas which need to be monitored for actuation of side airbags, and for driver and passenger airbags are shown in figure 2.

The radar sensing system monitors continually the zones of concern illustrated in figure 2 for intrusion by other vehicles or other obstacles. The predetermined areas are front of vehicle, rear of vehicle, drivers side and passenger side. The sensors 13 are used in pairs to track the trajectory of targets within their field of view. Time to impact is calculated using knowledge of relative velocities of the vehicle and target. If it is determined that a collision greater than a predetermined threshold speed is highly likely given the current dynamics of the situation, and the current driver actions, then a trigger signal (the pre-arm signal) is given to the airbag actuator to arm it in preparation for impact. The collision prediction unit also feeds a signal to the actuator to ensure that on inflation, the rate of inflation will be optimal.

Claims

1. An airbag deployment system 1 comprising an airbag inflator 3 operable to inflate the airbag at a variable rate dependant upon a signal from an airbag actuator 5, a sensing system 7 arranged to detect the presence of an object in a pre-determined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit 9 which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator 5 to indicate the rate of inflation required for the optimum protection to be provided by the airbag.

2. A system according to claim 1, in which the sensing system 7 is a radar sensing system.

3. A system according to claim 2, in which the sensing system includes at least two impulse radar transmitters and receivers.

4. A system according to any one of the preceding claims, in which the sensing system 7 is used also for providing driver information and warnings.

5. A system according to any one of the preceding claims, in which the system also includes an impact sensor 11 coupled to the airbag actuator 5, an airbag pre-arm mechanism, coupled to the airbag actuator 5, which comprises a pre-arm control system coupled to the sensing system which pre-arms the airbag actuator in readiness for an impact detected by the impact sensor 11 of the airbag deployment system.

6. A system according to claim 5, in which the airbag actuator has two stages in its operation, a pre-arm stage, where the airbag state is changed from non operating to a

ready to fill mode, and an actuation stage where the release of the gas to fill the airbag is initiated.

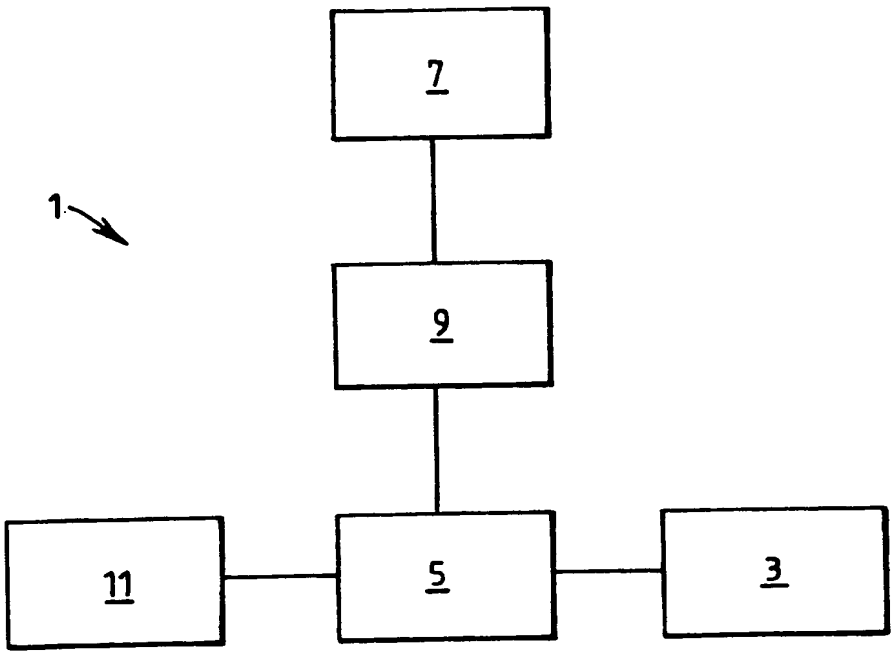

FIG.1

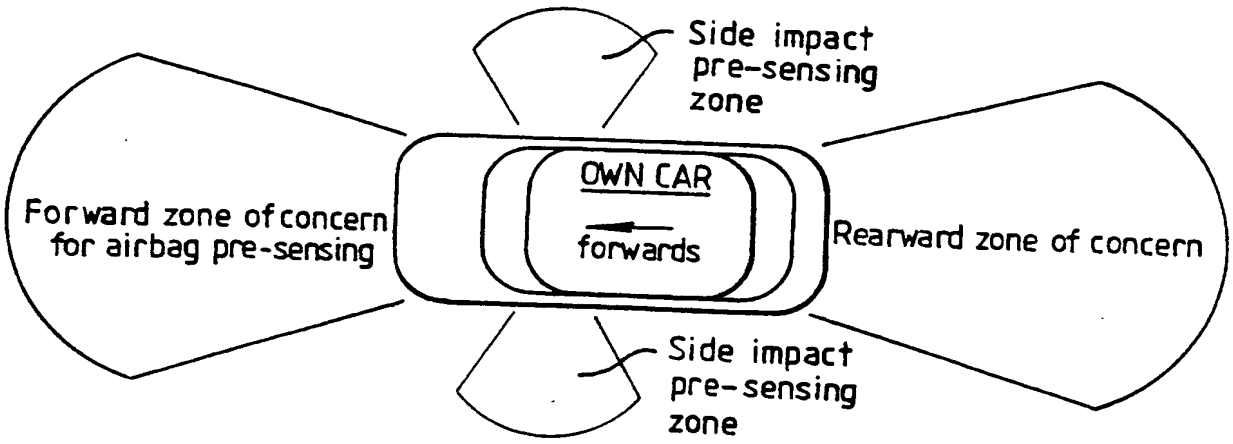
Side impact pre-sensing zone
OWN CAR
forwards
Forward zone of concern for airbag pre-sensing
Rearward zone of concern
Side impact pre-sensing zone

FIG.2

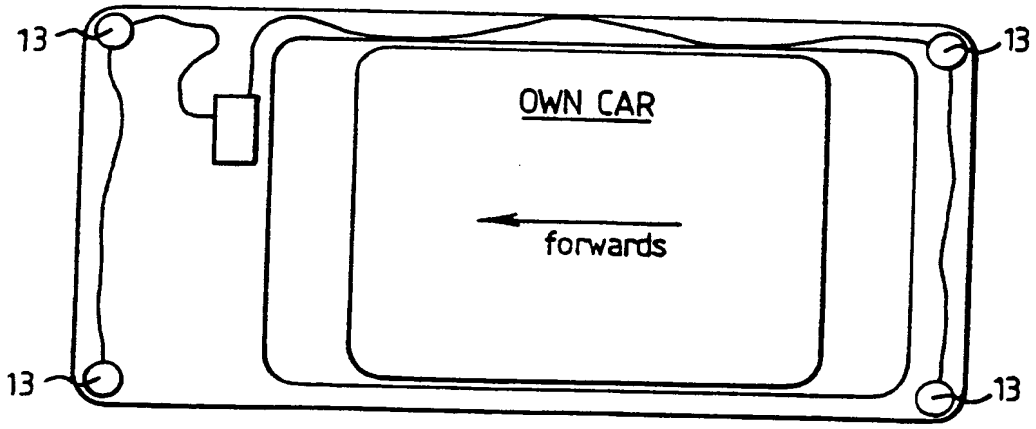
13
13
OWN CAR
forwards
13
13

FIG.3

INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/GB 97/02679

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B60R21/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B60R G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	see column 3, line 5-26 see column 4, line 11-15	3-6
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1

Date of the actual completion of the international search	Date of mailing of the international search report
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PCT/GB 97/02679

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INTERNATIONAL SEARCH REPORT

nformation on patent family members

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